Center Independent Research & Development: GRC IRAD

FY17 GRC: Magnetic Gearing - Establishing Core Competency

Completed Technology Project (2017 - 2018)

Project Introduction

Gears are machine components that allow speed and torque to be scaled. In spacecraft, roving vehicles, and aircraft, they are commonly used to connect a small, efficient motor to a load that requires slower speed and higher torque (e.g. a propeller, wheel, or drill). Contact between mating gear teeth causes several problems, including energy loss, noise generation, tooth wear, and tooth cracking. Lubricant is also required to reduce friction, but it tends to evaporate in low atmosphere or solidify at low temperature. This poses engineering challenges for Space systems, where gearing often needs to be protected in an atmospheric chamber. It was recognized over 100 years ago that magnets could be used to prevent gear tooth contact, thereby eliminating all of the aforementioned issues. Magnetic gearing technology evolved slowly, because magnets were relatively weak and their magnetic energy was not efficiently utilized. In the last 10 years, however, this technology has advanced exponentially. Although wind turbines have been the primary application, the lightest weight designs have been developed for automotive and robotic applications. The overarching goal for this project is to establish competency in magnetic gearing technology for US aerospace applications.

Anticipated Benefits

In aeronautics, one of the first applications for magnetic gearing could be in propulsion systems for on-demand-mobility (ODM) aircrafts. Currently most ODM aircraft designs use direct drive electric motors to turn their propellers. Geared motors could provide efficiency and weight benefits over direct drive motors as they allow the motor to operate at higher speed. However, geared motors are avoided in current designs due to mechanical gearing's added maintenance costs and potential noise. Unlike mechanical gearing, magnetic gearing has neither of these disadvantages and could be the enabling technology for geared motor's use in electric aircraft.

In Space, magnetic gearing could be an enabling technology for missions in harsh environments. Lubricating traditional gearing in the vacuum of Space and other harsh planetary environments can be a difficult or impossible problem to solve. Magnetic gearing requires no lubrication and in theory can operate indefinitely without wear.

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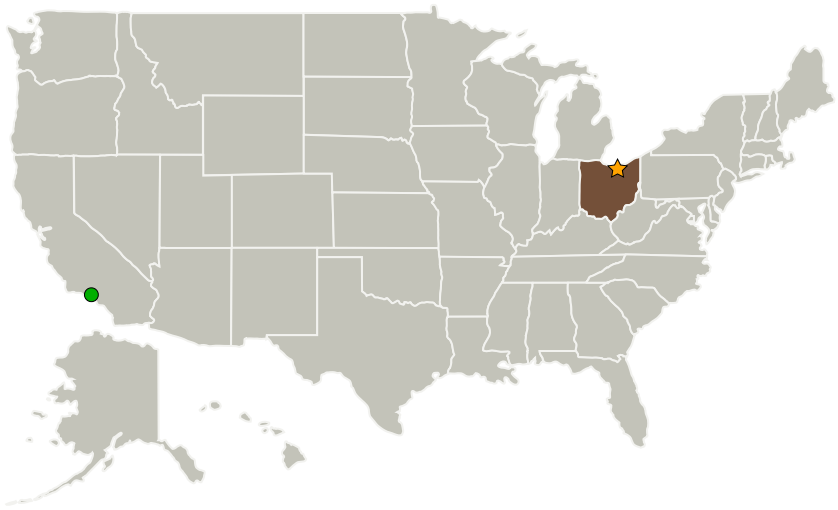
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Glenn Research Center(GRC)	Lead Organization	NASA Center	Cleveland, Ohio
●Jet Propulsion Laboratory(JPL)	Supporting Organization	NASA Center	Pasadena, California
Ohio State University-Main Campus	Supporting Organization	Academia	Columbus, Ohio

Primary U.S. Work Locations
Ohio

Project Transitions

May 2017: Project Start

Organizational Responsibility

Responsible Mission Directorate:

Mission Support Directorate (MSD)

Lead Center / Facility:

Glenn Research Center (GRC)

Responsible Program:

Center Independent Research & Development: GRC IRAD

Project Management

Program Manager:

Gary A Horsham

Project Manager:

Justin J Scheidler

Principal Investigators:

Justin J Scheidler
Vivake M Asnani

Co-Investigator:

Thomas F Tallerico

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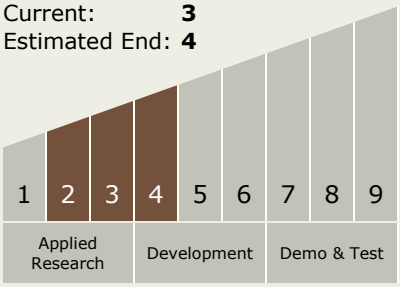
December 2018: Closed out

Closeout Summary: This project was adopted at the end of Phase II by the Aeronautics RLTV project office.

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **4**



Technology Areas

Primary:

- TX14 Thermal Management Systems
  - TX14.1 Cryogenic Systems
    - TX14.1.3 Thermal Conditioning for Sensors, Instruments, and High Efficiency Electric Motors

Target Destinations

Earth, The Moon, Mars

Supported Mission Type

Push